PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION.

Improvements in Variable Velocity Ratio Gearing.

We, ALFRED VERLING DAKIN, of 19, Weech Road, West Hampstead, London, N.W.6, and EDWIN LIONEL VIVIAN DAKIN, A.M.I.C.E., of 13, Bigwood Road, Hampstead Garden Suburb, London, N.W.11, both British subjects, do hereby declare the nature of this invention to be as follows:—

This invention relates to improvements in variable velocity ratio gearing for transmitting rotary motion from a driving shaft to a driven shaft.

The said invention provides a form of slipping clutch wherein the connection between the driving shaft and the driven shaft is made effective by the resistance offered by a flywheel, weighted radial arm or like comparatively heavy body, to oscillatory movement about a diameter or axis transverse to its principal axis of rotation.

According to this invention a fly-wheel is mounted so that it is free to oscillate about a diametral axis transverse to the longitudinal axis of the shaft on which it is mounted, the rotary motion of the fly-wheel on the axis of the shaft and its oscillatory movement about a diameter taking place simultaneously. The fly-wheel is provided with a laterally disposed annular surface on a plane oblique to the axis of the shaft and a corresponding oblique annular surface is provided on the driven shaft, these surfaces being in contact.

In place of a fly-wheel a weighted radial arm or arms may be provided and in place of the plane oblique surfaces, undulatory surfaces may be provided suitable to effect by their relative movement an oscillatory movement of the fly-wheel, arm or arms about an axis transverse to the shaft axis.

If desired suitable anti-friction rollers or balls may be intercalated between the oblique or undulatory surfaces.

In operation when the driving shaft is rotating carrying the fly-wheel with it in this motion, assuming the driven shaft is held against rotation, the relative motion between the shafts will be a maximum, and a maximum rate of oscillation will be imparted to the fly-wheel about a diameter thereof. The velocity ratio will then be infinity. The inertia of the fly-wheel resists such oscillation and thereby causes the oblique surface on the fly-wheel to act as a driving dog tending to cause the oblique surface on the driven shaft to rotate. As soon as the driven shaft commences to rotate a finite although large velocity ratio is established between the driving and driven shaft. As the speed of the driven shaft increases the velocity ratio between the shafts decreases until both shafts are rotating at the same speed. When there is no load on the driven shaft the driving and driven shafts will rotate together. On gradually applying an increasing load at some point slip will occur, providing a velocity ratio between the two shafts and this will be resisted and gradually overcome by the inertia of the flywheel resisting the oscillation thereof.

The resistance to oscillatory movement of the fly-wheel due to its inertia is supplemented by centrifugal force which tends to keep the fly-wheel, or radial arm in a plane transverse to its axis of rotation.

In a gear comprising a single fly-wheel considerable end thrust may be exerted between the oblique or undulatory surfaces. To avoid this a pair of fly-wheels may be mounted in a frame fast on the driving shaft and the driven shaft then passes freely through one of the fly-wheels and oblique or undulatory surfaces are provided at opposite ends of a bush keyed on the driven shaft between the two fly-wheels.

The improved driving gear may be combined with epicyclic gearing, for example, of the type comprising a driven sun wheel, a controlled sun wheel and a compound planet wheel in gear with the sun wheels and carried by a frame keyed to a driven shaft.

In a convenient constructional arrangement in accordance with this invention a sun wheel is keyed on the driven shaft and a second sun wheel is provided adjacent thereto, free to rotate upon or relatively to this shaft. A compound planet pinion in gear with both the above mentioned sun wheels is carried on a shaft or trun-

nion mounted on a disc or in a frame which is rotatable on or relatively to the driving shaft, and is keyed to or serves as the driven member. When the driving shaft is rotated, the driven member being restrained from rotation by the load imposed thereon, the compound planet wheel and the second sun wheel will rotate idly but, by imposing restraint on the said second sun wheel, restraint is imposed upon the compound planet pinion thus causing rotation of the disc or frame by which it is carried so that the driven member, overcoming the resistance of the load, commences to rotate.

An arm which may be loaded to increase its inertia is mounted in a frame keyed to the driven shaft. The axis of oscillation of this arm is transverse to its longitudinal centre line and passes transversely through the axis of the driving shaft, so that the longitudinal centre line of the arm can oscillate in a plane containing the axis of the driven shaft.

The second sun wheel can be mounted on a shaft extending coaxially within the driven shaft which for this purpose is made hollow and comprises two parts connected by the frame carrying the oscillating arm, so as to leave a gap in which a bush can be mounted, this bush being keyed to the shaft of the second sun wheel.

The diameters of the sun wheels and of the parts of the compound planet pinion are arranged so that when the disc or frame carrying the planet wheels is held still and the driven shaft is rotated, the second sun wheel will rotate at a higher speed than the driving shaft so that at such times the bush above mentioned is rotated rapidly relatively to the frame carrying the oscillatory arm and causes a corresponding rapid oscillation of the said arm. The bush is provided with an axially extending flange or rim having its end surface oblique to and on opposite sides of a plane which is transverse to the shaft and contains the axis of oscillation of the said arm and the latter is provided with an axially extending flange of similar shape to the flange on the bush so that the arm in its oscillatory movements is moved positively in both directions.

With this arrangement when the disc or frame of the epicyclic gear is rotating at a speed substantially lower than that of the driving shaft there is a comparatively quick relative movement between the two axial flanges causing a correspondingly rapid oscillation of the oscillatory arm which is resisted by its inertia so that a driving effort is exerted between the flanges tending to cause the controlled sun wheel to rotate with the driving shaft and ultimately to cause the two sun wheels to rotate at the same velocity. When this condition is attained the sun wheels act as dogs to drive the driven member at the same speed as the driven shaft.

When there is relative movement between the two sun wheels, the multiplying effect of the epicyclic gear is operative to enable the driving force applied at one speed to move a greater resisting force or load at a slower speed dependent upon the multiplying effect of the gear under the conditions at the moment.

The oscillatory arm can conveniently be in the form of a flat bar with its axis extending along a radial line intersecting the axis of the shaft, the bar extending equally on opposite sides thereof. Preferably two such oscillatory arms are provided arranged in one frame with the bush above referred to mounted between them with oblique or undulatory faces at its opposite ends arranged to move the bars in opposite directions simultaneously whereby a balancing of the forces tending to move the bush axially is attained.

At high speeds of the driving shaft the action of centrifugal force tends to hold the oscillatory arm or arms at right angles to the shaft, this result assisting in maintaining the bush rotating at the same speed as the arms, that is to say the speed of the driving shaft.

Dated this 22nd day of November, 1929.

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COMPLETE SPECIFICATION.

Improvements in Variable Velocity Ratio Gearing.

We, ALFRED VERLING DAKIN, of 19, Weech Road, West Hampstead, London, N.W.6, and EDWIN LIONEL VIVIAN DAKIN, A.M.I.C.E., of 13, Bigwood Road, Hampstead Garden Suburb, London, N.W.11, both British subjects, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to improvements

in variable velocity ratio gearing for transmitting rotary motion from a driving shaft to a driven shaft, of the kind including an epicyclic train which comprises elements respectively connected to the driving and driven shafts and is automatically controlled by a third element connected to inertia masses so as to oscillate them at speeds depending on the speed of the said third element, the inertia of the oscillating masses causing the train to operate as a variable velocity ratio gearing having a velocity ratio which varies automatically with the load.

The said invention provides a form of slipping clutch wherein the connection between the driving shaft and the driven shaft is made effective by the resistance offered by a rotary flywheel, weighted radial arm or like comparatively heavy body, to oscillatory movement about a diameter or axis transverse to its principal axis of rotation.

The flywheel or arm can be mounted to oscillate about an axis transverse to the driven shaft and to rotate therewith and may be provided with a flange in contact with a corresponding flange on a bush keyed to an intermediate shaft carrying a sun wheel in gear with a planet wheel carried by the driving or driven shaft, the faces of the flanges being suitably formed to effect oscillatory movement of the flywheel, or the like, when there is a relative rotational movement between the said intermediate shaft and the driving or driven shaft.

The flanges on the flywheel, or weighted arm are provided with suitably formed oblique or undulatory contacting faces to effect by their relative movement an oscillatory movement of the flywheel, or arm about an axis transverse to the shaft axis.

If desired suitable anti-friction rollers or balls may be intercalated between the oblique or undulatory surfaces.

In a gear comprising a single flywheel, considerable end thrust may be exerted between the oblique or undulatory surfaces. To avoid this a pair of flywheels may be mounted in a frame fast on the driving shaft and the driven shaft then passes freely through one of the fly-wheels and oblique or undulatory surfaces are provided at opposite ends of a bush keyed on the driven shaft between the two flywheels.

The improved driving gear may be combined with epicyclic gearing, for example of the type comprising a driven sun wheel, a controlled sun wheel and a compound planet wheel in gear with the sun wheels and carried by a frame keyed to a driving shaft.

In the accompanying drawing:

Figure 1 is a diagram of the essential parts of variable velocity ratio gearing constructed in accordance with this invention.

Figure 1 shows a longitudinal section of one form of the improved gearing.

Figure 3 shows a section of the gearing on the line A—A, Figure 2.

Figure 4 shows a section of the gearing on the line B—B, Figure 2.

As shown in Figure 1, a driving shaft 1 is supported coaxially with an ultimate driven shaft 2 by an intermediate driven shaft 3. A sun wheel 4 is keyed on the driven shaft 2, and a second sun wheel 5 is provided keyed on the intermediate shaft 3 adjacent to the sun wheel 4 and free with its shaft to rotate relatively thereto. A compound planet pinion 6 in gear with both the above mentioned sun wheels is carried on a shaft or trunnion 7 mounted on a disc 8 or in a frame which is rotatable on or relatively to the intermediate shaft 3, and is keyed to or integral with the driving shaft 1. When the driving shaft is rotated, if the driven member is restrained from rotation by the load imposed thereon, the compound planet wheel 6 and the second sun wheel 5 will rotate idly but, by imposing restraint on the said second sun wheel, restraint is imposed upon the compound planet pinion 6 thus causing rotation of the sun wheel 4 so that the driven member, overcoming the resistance of the load, commences to rotate.

An arm 9 which may be loaded to increase its inertia is mounted in a frame 10 keyed to or integral with the driven shaft. The axis or oscillation 11 of this arm is transverse to its longitudinal centre line and passes transversely through the axis of the driving and driven shafts, so that the longitudinal centre line of the arm can oscillate in a plane containing the axis of these shafts. The arm 9 may be in the form of a slotted bar, frame or wheel so that parts thereof are symmetrically disposed about the centre line of the shafts.

The intermediate shaft 3 extends coaxially within the driving and driven shafts which for this purpose are made hollow and the driven shaft comprises two parts connected by the frame 10 carrying the oscillating arm 9, so as to leave a gap in which a bush 12 can be mounted, this bush being keyed to the shaft 3 of the second sun wheel. The bush 12 is provided with a flange or rim having its end surface 13 in contact with a flange or ring 14 on the arm 9, the faces in contact being suitably shaped so that on relative rotational movement of the flanges 13, 14

about the axis of the shafts, an oscillatory movement is imparted to the arm about the axis 11 and the arm in its oscillatory movements is moved positively in both directions.

The diameters of the sun wheels 4, 5 and of the parts of the compound planet pinion 6 are arranged so that when the driving shaft 1 and the disc or frame 8 carrying the planet wheels are rotated and the driven shaft 2 is stationary, the second sun wheel 5 and its shaft 3 will rotate at a high speed and at such times the bush 12 is rotated rapidly relatively to the frame 10 carrying the oscillatory arm and thus causes a corresponding rapid oscillation of the said arm.

With this arrangement also when the driven shaft is rotating, but at a speed substantially lower than that of the driving shaft there is a comparatively quick relative movement between the two flanges 13, 14 causing a correspondingly rapid oscillation of the oscillatory arm which is resisted by its inertia so that a retarding effort is exerted between the flanges tending to reduce or prevent the relative movement of the flanges which effects the oscillatory movement of the arm and to cause the controlled sun wheel to rotate with the driven shaft and ultimately to cause the two sun wheels to rotate at very nearly the same velocity. When this condition is attained the sun wheels act more or less as dogs to drive the driven member.

When there is relative movement between the two sun wheels, the multiplying effect of the epicyclic gear is operative to enable the driving force applied at one speed to move a greater resisting force or load at a slower speed dependent upon the multiplying effect of the gear under the conditions at the moment.

The oscillatory arm can conveniently be in the form of a flat bar with its axis extending along a radial line intersecting the axis of the shaft, the bar extending equally on opposite sides thereof. Preferably two such oscillatory arms 9, 9*a* are provided arranged in one frame 10 with the bush above referred to mounted between them with oblique faces 13, 13*a* at its opposite ends engaging undulatory faces 14 and arranged to move the bars in opposite directions simultaneously whereby a balancing of the forces tending to move the bush axially is attained.

At high speeds of the driving shaft the action of centrifugal force tends to hold the oscillatory arm or arms at right angles to the shaft, this result assisting in maintaining the bush rotating at nearly the same speed as the arms, so that with little relative motion between the two sun wheels 4, 5, the speed of the driven shaft approximates to that of the driving shaft.

The functions of the shafts 1 and 2 can be exchanged and on the shaft 2 becoming the driving shaft, when the shaft 1 is stationary the shaft 2 drives the compound planet pinion 6 and the sun wheel 5 is thereby rotated so as to rotate the bush 12 and impart an oscillatory movement to the arm 9. The resistance to movement offered by the said arm retards the bush 12 and sun wheel 5 so that the disc or frame is set in rotation.

In the constructional form of the gearing illustrated in Figures 2, 3 and 4, the shaft 15 rotatably supports two sleeves or tubular shafts 16 with flanges 17 at their adjacent ends keyed to the shafts 16 and connected by a tubular frame part 17*a*. The sleeves 16 are rotatable in bearings 18 carried by supporting standards 19. The frame part 17*a* supports brackets 20 in diametrically opposite positions thereon providing bearings 21 for trunnions 22 for ejecting from opposite sides of fly-wheels 23 which can thus oscillate about the centre line of the trunnions whilst rotating about the axis of the shafts 15, 16.

Each fly-wheel 23 has a ring 24 secured by bolts 25 to the hub portion 26 thereof. Each ring is made in two parts to allow bearing blocks 27 to be inserted therein to support rollers 28, and a bush 29 mounted on the shaft 15 between the fly-wheels comprises two parts rotatable with the shaft 15 and capable of sliding axially thereon for a limited distance. The bush 29 is provided with oblique faces on which the rollers 28 travel and a spring 30 is provided to force the two parts of the bush towards the corresponding rollers under a yielding pressure.

A supporting standard 31 carries a bearing 32 for a shaft 33 with an integral end plate 34 in which pins or trunnions 35 are mounted the outer ends of the pins or trunnions being supported by a plate 36 rotating on the hub portion of a sun wheel 37 keyed on the shaft 16. One of these trunnions carries a compound pinion 38 in gear with the sun wheel 37 and with a sun wheel 39 keyed on the shaft 15. Each of the pins or trunnions may carry a similar compound pinion or one of the pins or trunnions may carry a counterweight 40 in place of a compound pinion.

The operation of these parts is similar to that above described with reference to the arrangement illustrated in Figure 1. When the driving shaft is rotating carrying the fly-wheel with it in this motion, assuming the driven shaft is held against rotation, the relative motion between the shafts will be a maximum, and

a maximum rate of oscillation will be imparted to the fly-wheel about a diameter thereof. The velocity ratio will then be infinity. The inertia of the fly-wheel resists such oscillation and thereby causes the rollers on the fly-wheel to act as driving dogs to cause the bush on the driven shaft to rotate. As soon as the driven shaft commences to rotate a finite although large velocity ratio is established between the driving and driven shafts. As the speed of the driven shaft increases the velocity ratio between the shafts decreases until both shafts are rotating at nearly the same speed. When there is no load on the driven shaft the driving and driven shafts will rotate together. On gradually applying an increasing load at some point slip will occur, providing a velocity ratio between the two shafts and this will be resisted and gradually overcome by the inertia of the fly-wheel resisting the oscillation thereof.

The resistance to oscillatory movement of the fly-wheel due to its inertia is supplemented by centrifugal force which tends to keep the flywheel, or radial arm in a plane transverse to its axis of rotation.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed we declare that what we claim is:—

1. Variable velocity ratio gearing of the kind referred to comprising a driving and a driven shaft connected by sun and planet wheels, wherein the connection between the driving shaft and the driven shaft is made effective by the resistance offered by a rotary fly-wheel, weighted radial arm or the like, to oscillatory movement about a diameter or axis, transverse to its principle axis of rotation.

2. Variable velocity ratio gearing as claimed in Claim 1, wherein the rotary fly-wheel or the like, is mounted to rotate coaxially with the driving and driven shafts and to oscillate about an axis transverse to this axis of rotation.

3. Variable velocity ratio gearing as claimed in Claim 1, wherein the rotary fly-wheel or the like, controls the rotation of a planet wheel which is in gear with a sun wheel on the driving, or driven shaft, through a sun wheel which is coaxial with the said rotary fly-wheel or like member.

4. Variable velocity ratio gearing as claimed in Claim 1, wherein the rotary fly-wheel, or the like, is provided with a flange in contact with a corresponding flange on a bush keyed to an intermediate shaft carrying a sun wheel in gear with a planet wheel carried by the driving or driven shaft, the faces of the flanges being suitably formed to effect oscillatory movement of the fly-wheel, or the like when there is a relative rotational movement between the said intermediate shaft and the driving or driven shaft.

5. A constructional form of the gearing claimed in Claim 4, wherein one of the flanges is replaced by a series of rollers.

6. Variable velocity ratio gearing constructed and operating substantially as hereinabove described with reference to Figure 1, or to Figures 2, 3 and 4, of the accompanying drawing.

Dated this 22nd day of August, 1930.

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Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1931.

[This Drawing is a reproduction of the Original on a reduced scale]